

CHAPTER 1 - INTRODUCTION

1.1 Rationale of study

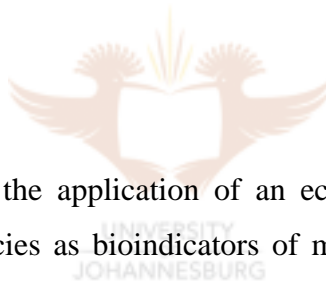
Increasingly, both public and government agencies are interested in assessing the well-being of organisms, populations, communities and ecosystems (Roux, 2004). The recognition of the occurrence, importance and effects of contaminants on food chains and ecosystems has led to the development of biomonitoring programmes that use indicator species to estimate the levels in other parts of the ecosystem (Burger, 1993). There has been an increased awareness of potential pollution of ecosystems of Gauteng Province, South Africa, because of increased formal and informal urbanization, industrialization and mining activities.

Studies by Schoonbee *et al.* (1995) showed that there is a high degree of metal contamination in the wetland ecosystems of Gauteng. However, these studies did not attempt to link metal burdens in organisms with biological or ecological effects. It is therefore essential to obtain clear indications of metal pollution cause-effect relationships at ecosystem level in order to carry out effective management of these ecosystems.

The aim of ecotoxicological studies is to relate levels of contaminants in ecosystems to effects at organism level and how that affects the population, community and ecosystem structure (Connell *et al.*, 1999). In order to achieve this it is necessary to measure levels of contaminants in the environment and organisms, relate the body burdens (bioaccumulation) to biochemical and/or physiological responses (biomarkers), which in turn are related to the ecological community structure of the organisms (i.e. diversity and abundance). Birds have been shown to be particularly useful bioindicators because they are visible, sensitive to toxicants and high on the food chain and as such form important structural components of the ecosystem (Burger and Gotchfeld, 1995). They therefore give early warnings of environmental stress and are of general interest to the public.

Bird feathers (or parts of them), excrement and egg shells has been used as a non-invasive indicator of metal exposure in birds (Eens *et al.*, 1999; Dauwe *et al.*, 2000; Vallner *et al.*, 2000; Goutner *et al.*, 2001). The use of feathers has several advantages over the tissues for the measurement of metal contamination in birds. Feathers are easy to collect, easy to store, non-invasive and non-destructive, can be collected from live birds, which is particularly appropriate for rare and declining species and feathers tend to accumulate metals at higher concentrations compared to other tissues. In order to relate bioaccumulation to effects at organism level, non-destructive biomarker assays of oxidative stress (i.e. serum esterases - Cordi *et al.*, 1998) and genotoxicity (i.e. red blood cell DNA damage – Pastor *et al.*, 2001) have been carried out successfully on natural bird populations, subjected to environmental stressors. Finally bird survey results are integrated with bioaccumulation and biomarkers results to elucidate ecological effects of exposure contaminants.

1.2 Aims and objectives



The first aim of the study is the application of an ecotoxicologically-based study of metals in selected weaver species as bioindicators of metal pollution of ecosystems in Gauteng.

To reach this aim, several objectives were recognised.

- Measurement of levels of contaminants in the organisms (feathers).
- Relating metal bioaccumulation to biochemical and/or physiological responses (biomarkers).

Internationally there is a trend to incorporate Ecological Quality Objectives (EcoQOs) into legislation, especially when dealing with metal contamination. Within the framework of EcoQOs developed for birds the monitoring of contaminants forms a specific category of EcoQOs. However, due to a lack of available data, Reference and Target Levels, however, still need to be set. These also need to be adapted for each bird species. The development of EcoQOs is especially important at this stage in South

Africa. The recently promulgated National Biodiversity Act (10 of 2004) specifically provides for the preparation of conservation plans for identified ecosystems that are important because of their goods and services that they provide because of threats to this element of biodiversity. Since there is no management tool available at present to develop a suitable management plan, the setting of EcoQOs that are in line with international standards and practices will be of immeasurable value to implementing the Act.

The second aim of the project is to develop EcoQOs for weavers in Gauteng, South Africa. To reach this aim, the objective was to use both data from samples collected in the field and from museum specimens to get the Current, Reference and Target Levels.

After a thorough and comprehensive literature study two working hypotheses were constructed. The first working hypothesis states that the metal content of feathers and biomarker responses are able to indicate metal pollution gradients in the selected study area. The second working hypothesis states that the metal content of feathers from museum specimens can be used to determine Reference Levels from which Target Levels can be calculated. These Target Levels can then be compared to the Current Levels determined from field samples.

1.3 Structure of the dissertation

Chapter 2 presents a literature survey into the use of birds as bioindicators, the use of feathers and biomarkers in bioaccumulation monitoring and Ecological Quality Objectives. The various materials and methods used in this study are explained in Chapter 3. These include the biomarkers and the metal analysis of the feathers. Chapter 4 deals with the spatial and temporal variation in the metal levels of the feathers at the different sites. The results of the haematological studies are discussed in Chapter 5. Chapter 6 deals with the spatial and temporal variation in the biomarkers during the study. The results of each biomarker are discussed and then multivariate analysis is performed on the data. The Ecological Quality Objectives determined for this study is

given in Chapter 7, along with results from the metal analysis of the feathers taken from museum specimens. In Chapter 8 some general conclusions and recommendations are given regarding the study and future projects.

